Assignment 17.4. Questions #64, 77, 79, 84, 86, 88, 92, 95

64)

$$E = E^o - \frac{0.0592}{n} \log Q \qquad Q = \frac{[Ag^+]\ \text{anode}}{[Ag^+]\ \text{cathode}}$$

$$0.76 = -\ 0.0592 \log Q$$

$$Q = 1.45 \times 10^{-13}$$

$$1.45 \times 10^{-13} = \frac{[Ag^+]\ \text{anode}}{0.10\ M}$$

$$[Ag^+]\ \text{anode} = 1.5 \times 10^{-14}\ M$$

b. $Ag^+(aq)\ +\ 2\ S_2O_3^{2-}(aq) \qquad Ag(S_2O_3)_2^{3-}(aq)$

$$K = \frac{[Ag(S_2O_3)_2^{3-}]}{[Ag^+]\ [S_2O_3^{2-}]^2} = \frac{[1.0\ \times 10^{-3}]}{[1.45 \times 10^{-14}]\ [0.050]^2} = 2.8 \times 10^{13}$$

77)

1000g Al	1 mol Al	3 mol e-	96,500 C	1 s	1 min	1 hr	
	26.98g Al	1 mol Al	1 mol e-	100.0 C	60 s	60 min	**= 30. hr**

100 A = 100 C/s

1.0g Ni	1 mol Ni	2 mol e-	96,500 C	1 s	
	58.69g Al	1 mol Ni	1 mol e-	100.0 C	**= 33 s**

5 mol Ag	1 mol e-	96,500 C	1 s	1 min	
	1 mol Ag	1 mol e-	100.0 C	60 s	**= 80. min**

79)

60. min	60 s	15 C	1 mol e-	1 mol Co	58.93 g Co	
	1 min	1 s	96,500 C	2 mol e-	1 mol Co	**= 16 g Co**

15 A = 15 C/s

1 mol Hf	178.5 g Hf	
4 mol e-	1 mol Hf	**= 25 g Hf**

1 mol I_2	253.8 g I_2	
2 mol e-	1 mol I_2	**= 71 g I_2**

1 mol Cr	52.00 g Cr	
6 mol e-	1 mol Cr	**= 4.8 g Cr**

84) $2H_2O(l) \longrightarrow 2H_2(g) + O_2(g)$

15 min	60 s	2.5 C	1 mol e-	2 mol H_2	22.4 L H_2	
	1 min	1 s	96,500 C	4 mol e-	1 mol H_2	**= 0.261 L $H_{2(g)}$**

1 mol O_2	22.4 L O_2	
4 mol e-	1 mol O_2	**= 0.131 L $O_{2(g)}$**

86) $Al^{3+} + 3e^- \longrightarrow Al(s)$

$$\frac{2000\ \text{lbs}}{} \times \frac{1\ \text{kg}}{2.2\ \text{lbs}} \times \frac{1000\text{g}}{1\ \text{kg}} \times \frac{1\ \text{mol Al}}{26.98\ \text{g Al}} \times \frac{3\ \text{mol e-}}{1\ \text{mol Al}} \times \frac{96{,}500\ \text{C}}{1\ \text{mol e-}} = 9.75 \times 10^9\ \text{C}$$

$$\frac{24\ \text{hours}}{} \times \frac{60\ \text{min}}{1\ \text{hr}} \times \frac{60\ \text{s}}{1\ \text{min}} = 86{,}400\ \text{s}$$

$$I = \frac{9.75 \times 10^9\ \text{C}}{86{,}400\ \text{s}} = \mathbf{110{,}000\ amps}$$

88)

$$\frac{0.50\ \text{L}}{} \times \frac{0.0099\ \text{mol Pt}}{1\ \text{L}} \times \frac{4\ \text{mol e-}}{1\ \text{mol Pt}} \times \frac{96{,}500\ \text{C}}{1\ \text{mol e-}} \times \frac{1\text{s}}{4.00\ \text{C}} \times \frac{1\ \text{min}}{60\ \text{s}} = 8.0\ \text{min}$$

92a) Possible oxidation reactions:

$2Br^-(aq) \longrightarrow Br_2(g) + 2e^-$ **$-E^o = -1.09\ V$**

$2H_2O \longrightarrow O_2(g) + 4H^+(aq) + 4e^-$ $-E^o = -1.23\ V$

It's easier to oxidize bromine, which makes it a better anode

Possible reduction reactions:

$Ni^{2+}(aq) \longrightarrow Ni(s) + 2e^-$ **$E^o = -0.23\ V$**

$2H_2O + 2e^- \longrightarrow H_2(g) + 2OH^-(aq)$ $E^o = -0.83\ V$

Easier to reduce nickel, which makes it a better cathode

92b) Possible oxidation reactions:

$2F^-(aq) \longrightarrow F_2(g) + 2e^-$ $-E^o = -2.87\ V$

$2H_2O \longrightarrow O_2(g) + 4H^+(aq) + 4e^-$ **$-E^o = -1.23\ V$**

Easier to oxidize water, so oxygen will be produced at the anode.

Possible reduction reactions:

$Al^{3+}(aq) \longrightarrow Al(s) + 3e^-$ $E^o = -1.66\ V$

$2H_2O + 2e^- \longrightarrow H_2(g) + 2OH^-(aq)$ **$E^o = -0.83\ V$**

Easier to reduce water, so hydrogen will be produced at the cathode.

c) Possible oxidation reactions:

$2I^-(aq) \longrightarrow I_2(g) + 2e^-$ **$-E^o = -0.54\ V$**

$2H_2O \longrightarrow O_2(g) + 4H^+(aq) + 4e^-$ $-E^o = -1.23\ V$

Easier to oxidize iodine, so iodine gas produced.

Possible reduction reactions:

$Mn^{2+}(aq) \longrightarrow Mn(s) + 2e^-$ $E^o = -1.18\ V$

$2H_2O + 2e^- \longrightarrow H_2(g) + 2OH^-(aq)$ **$E^o = -0.83\ V$**

Easier to reduce water. Hydrogen produced at the cathode.

95) Anode: $2Cu \longrightarrow Cu^{2+} + 2e^-$ $-E^\circ = -0.34$ V

Cathode: $Ag^+ + e^- \longrightarrow Ag$ $E^\circ = 0.80$ V

$2Cu + 2Ag^+ \longrightarrow Cu^{2+} + 2Ag_{(s)}$ $E^\circ = 0.46$ V

$$Q = \frac{[Cu^{2+}]}{[Ag^+]^2} \qquad E = E^\circ - \frac{0.0592}{n} \log Q$$

a. As $[Cu^{2+}]$ increases, Q increases. If Q increases, E decreases.

b. If NH_3 reduces $[Cu^+]$, Q decreases. If Q decreases, E increases.

c. If $[Ag^+]$ decreases, Q increases. If Q increases, E decreases a little.

d. If both concentrations are halved, Q will increase. The dilution will affect $[Ag^+]$ more because it is squared. If Q increases, E decreases.

e. Ag does not oxidize to become Ag^+, so the platinum will not affect the cell potential. Also, solids are not in the equation for Q.